Dual-Polarization Technology Arrives for KFCX

What is Dual-Pol?

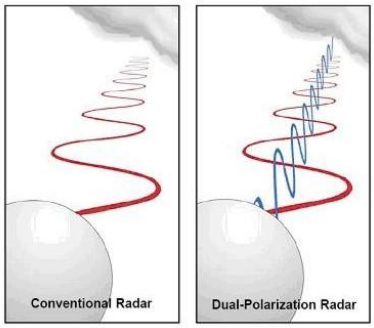
A major upgrade is being installed in all National Weather Service (NWS) radars across the nation. Dual-Polarization technology takes each sweep of the radar from 2-D, to 3-D. Before Dual-Pol, a radar beam was transmitted only in the horizontal plane, so the beam could only receive data about falling precipitation in one direction. The dual polarization radar is scheduled to be installed at National Weather Service in Blacksburg from October 8, 2012 starting around 7:00 am and continuing until October 21, 2012.

With October's upgrade to our local NWS radar, forecasters can now get information about precipitation not only in the horizontal but in the vertical as well. This tells us much more about what the radar is sampling. Dual-Pol is a vital part of the Weather-Ready Nation effort by the NWS. Creating a Weather-Ready Nation requires providing the media, government and other key partners with the most accurate warnings and forecasts to protect lives and property.

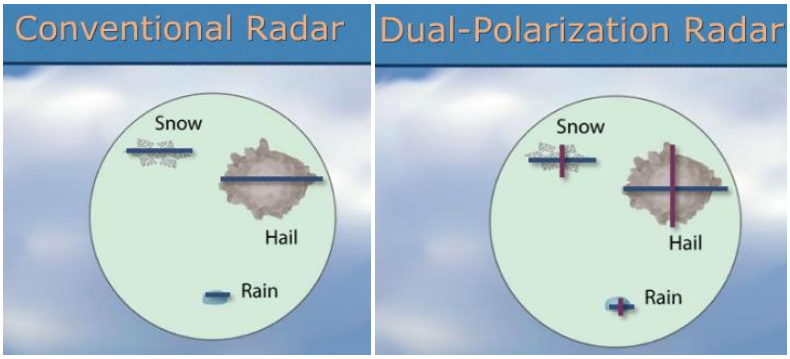
What are the functions of Dual-Pol data compared to the conventional radar data?

Conventional radar products only allow forecasters to see the "brightness" of clouds and precipitation (raindrops, hail, snowflakes, etc.). The larger the raindrop or hailstone, the "shinier" it will appear to the radar. On a radar screen, the most reflective objects correspond to the more intense colors on the color wheel, red, pink, bright purple. Conversely, light precipitation will have the less alarming colors, light greens and blues, maybe even gray for the lightest drizzle or flurries.

The image below shows the difference between a beam that a conventional radar would emit, compared to one that is equipped with dual-polarization technology. Conventional radar beams only emit a frequency in the horizontal plane, while a dual-polarized beam sends and receives information in both the horizontal and vertical planes - creating a 3-dimensional view. The two images on the right show this in terms of individual precipitation forms, a snowflake, hailstone, and raindrop.

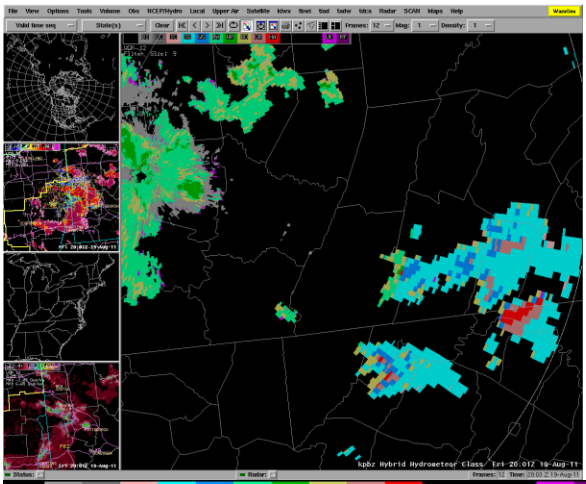


(Graphics: Radar Operation Center)



(Graphics: WDTB)

Dual-Pol products can show precipitation characteristics in a number of ways to meteorologists. The radar can then take all of that information and make its best estimate of what type of precipitation is in the sky. In the lower right of the below Dual-Pol radar image is an example of summer thunderstorms over southern Pennsylvania and north central Maryland from the NWS Dual-Pol radar in Pittsburgh. Since the radar beam shoots out at an angle away from the ground, far away from the radar, the beam for the northern Maryland storms is high within the tops of the clouds. Up there, it is well below freezing and the radar can see the irregular shape of the ice crystals in the cloud - the blues. However, it can also tell the difference between those ice crystals and the red that signifies hail in the storm.



BI	GC	IC	DS	WS	RA	HR	BD	GR	HA	UK	RF

HCA

Biological Scatterers	Birds, Bats, Insects: Low reflectivity (Z), very high ZDR, very low CC
Ground Clutter/AP	High Z, low CC and ZDR. Velocity must be less than +/- 2 kts
Ice Crystals	Plates, Columns, Needles: Low reflectivity, very high CC, positive ZDR
Dry Snow	Aggregated Crystals: Similar dual-pol values as with Ice Crystals but with a lower ZDR
Wet Snow	Bright band/melting snow: Much lower CC, higher Z and ZDR than Dry Snow
Light/Mod. Rain	Rain rates less than 1.1 in/hr. Positive KDP, ZDR, Z < 45 dBZ
Heavy Rain	Rain rates greater than 1.1 in/hr. Positive KDP, ZDR, Z > 45 dBZ
Big Drops	Large drops in small concentrations. Very high ZDR, low Z. Seen along storm edges.
Graupel	Round or conical snow pellets < 5 mm diameter. High CC and ZDR < 2 dB
Hail-Rain	Hail Possibly Mixed with Rain: High Z, Low ZDR, Lower CC
Unknown	Confidence in any particular classification is too low to make a guess
Range Folding	Unlikely to show up in dual-pol products

(Right-hand graphic: WDTB)

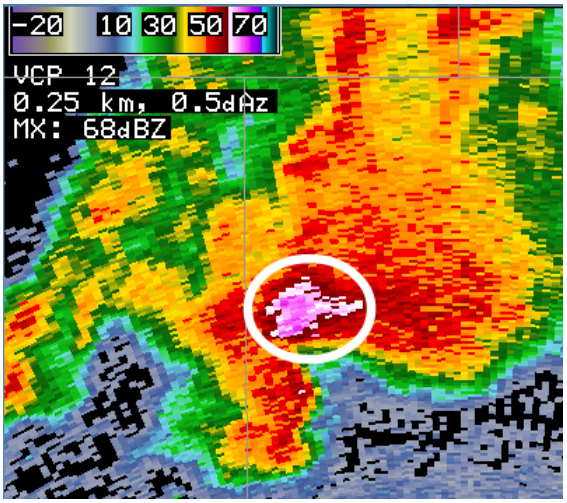
Why is Dual-Pol important for the Mid-Atlantic Region?

Finding Hail: In terms of severe storms, most of our typical summertime storms are pulse thunderstorms, lasting only 20-30 minutes on average. Unlike supercells which can last anywhere from an hour to several hours, pulse thunderstorms form within a few minutes, develop their core of hail and wind, and dissipate shortly thereafter. When these storms contain hail and damaging winds, NWS forecasters need to be able to quickly see it to help get the warning out before any of that hail or damaging wind reaches the ground.

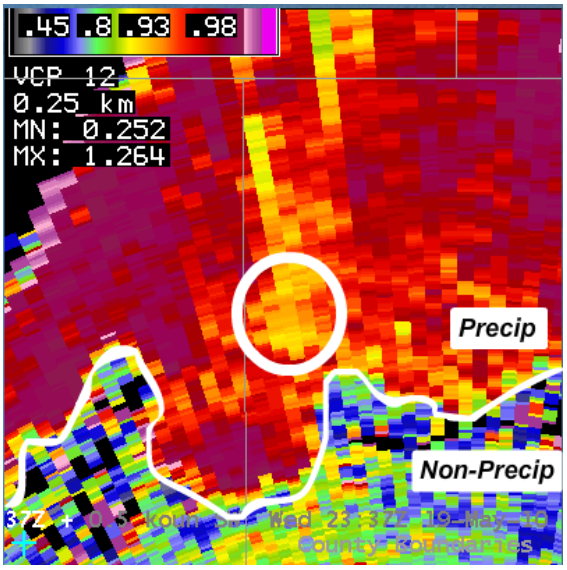
Winter Precipitation: Dual-Pol technology gives meteorologists a new set of highly sophisticated tools to better diagnose and determine precipitation types at all levels of the lower atmosphere. The zone of mixed precipitation in-between can be a relatively short distance and change quickly, so having tools that give forecasters better clues as to where the in-cloud melting/freezing layers are and how they are changing will be crucial to providing better service for our region for years to come.

Better Rainfall Estimates: Conventional radar can only rely on assigning rainfall rates to how reflective the precipitation is. This is an issue if hail is present within an area of rain. Hail appears very bright like torrential rain, but causes no flooding. Dual-Pol radars automatically account for areas of rain that have hail mixed in and give a more realistic estimation for how much rain has fallen. This is crucial since flooding is the #1 weather storm related killer. We need to have accurate rainfall estimation to provide the best possible flood warnings and help people get out of harm's way.

What are the new products available with Dual-Pol?

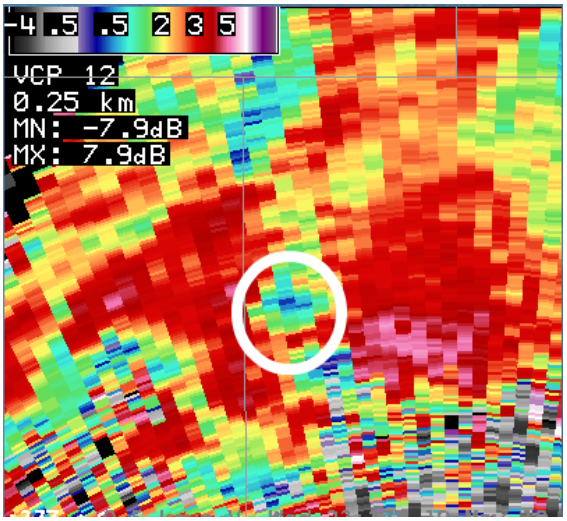


There are three base products, each of them go into creating the Hydrometeor Classification (HC) product, previously mentioned. One of the best examples to show each of the new Dual-Pol products, and what purpose they can serve, is to go through a case with hail in a thunderstorm. Let's start off with what we are more used to seeing, the lowest tilt Reflectivity product. A white oval surrounds the area just north of the storm's updraft where large hail is likely falling. Reflectivity, however, only shows how "reflective" the surfaces of raindrops, hail, ice and snowflakes, not giving much more information about the echo.



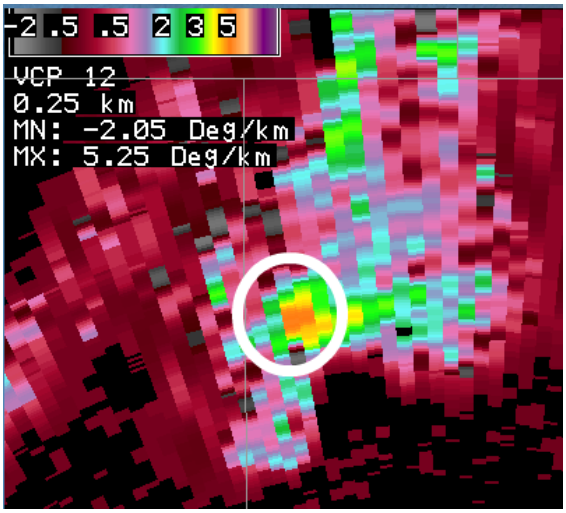
However, when hail is present and mixed in with rain, different characteristics can be seen with Dual-Pol products that cannot be detected by conventional radar. Looking at Correlation Coefficient (CC) product gives us a few key pieces of information:

1). Which echoes are precipitation and non-precipitation (ground clutter).
2). Where echoes are the same type of precipitation and where there is a mix of different precipitation types. The magenta and dark reds are where precipitation types are the same, in this case, all rain. Once you see a mix of lighter oranges and yellows, there is a mix of other precipitation types, in this case, hail.
3). The white circle denotes the same region in the Reflectivity image that is the core of hail.



The other two products show the same hail core feature, in different ways. The Differential Reflectivity (ZDR) product shows the height vs. width difference for each echo. Rain drops are wider (as they are falling) than they are tall, so their ZDR will be a positive value. Conversely, ice crystals and some graupel appear taller than they are wide, so they will return negative values of ZDR. Hail, since it is mostly round will have values closer to zero, since the height vs. width difference is about zero. In the image to the right, the white circle shows the same hail core region, where the values are much closer to zero than the pixels surrounding it.

Lastly, for the hail example, is Specific Differential Phase Shift (KDP). Hail, raindrops, snowflakes and other precipitation types will fall all out of a cloud in different ways. Most raindrops will normally fall straight down, with not much randomness involved. Snowflakes, however, have completely random motions as they fall toward the surface. Even hail will "tumble" as it falls. The more random the falling motion, the higher the value for KDP. The white circle showing the same hail core region shows high values of KDP, which reflects the highly random motion from the medium-to-large sized hail that is falling out of the thunderstorm.



(All images courtesy WDTB: http://www.wdtb.noaa.gov/courses/dualpol/trainingaid/index.htm)

Now that we have Dual-Pol, how can I learn more about it?

Training Courses: There are a number of web sites that offer information on the new suite of Dual-Pol products and what each of these products provides. There are different levels of training for the Dual-Pol products and applications for meteorologists and non-meteorologists:

http://www.wdtb.noaa.gov/courses/dualpol/outreach/

Training Aides: Here, you can view short instructor-led web modules with full explanations, accompanying graphics and real world examples. Also provided are helpful aides to better understand each of the individual Dual-Pol products:

http://www.wdtb.noaa.gov/courses/dualpol/trainingaid/index.htm

How can I access Dual-Pol data?

Dual-Pol data will be flowing into our local NWS office to help measure our atmosphere better and improve weather warnings. At the moment, NWS public radar pages do not include Dual-Pol products. Many of the WSR-88Ds around the country have yet to be upgraded, so there will be some time before it is readily available to the public. However, radar data are available for download and can be viewed from online and downloadable java viewers provided by the National Climatic Data Center (NCDC), here:

http://www.ncdc.noaa.gov/oa/radar/radardata.html

There are also a number of commercial vendors that offer specialized viewing software applications for conventional and Dual-Pol radar data that our local media can utilize.

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